# GROWTH HABITS OF SHORT-ROTATION AND PERENNIAL RYEGRASS

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In this paper there will be no attempt to give answers to immediate field problems. Rather it is hoped to indicate the lines of approach which are being used in studying the physiology of growth of our pasture species,

'There are three stages of development for this work. First, the ascertainment of the influence of various environmental conditions on the manner of growth of the pasture species. Just how do changes in light, temperature, or nutrition influence the rate of tillering and rate of dry matter formation of the different species ?

Secondly, there is the quantitative measurement of the performance and efficiency of growth of the plants. This has to be done in growth cabinets where light and temperature can be set at fixed levels and held constant there.

Thirdly, there is need to find out the conditions of light, temperature, etc., to which the plants are subjected under field conditions. These are then related back to knowledge gained in the two previous sections to give direct consideration of field problems.

To use a fairly simple analogy, when you meet a new type of machinery the first job is to find out how it works, secondly to measure its performance, and thirdly to see what conditions it has to meet in field operation.

The first phase of the work has been largely completed for the ryegrasses and is now being extended to paspalum, browntop, and cocksfoot. Aspects of that will be described here.

Some work with a controlled environment cabinet was carried out in England and a group of larger and more powerful units are now being erected at Grass-made up of my brother, myself, a married couple, and one other permanent man, plus of course casual labour at shearing. There are 2 houses on the place, the homestead and the married couple's cottage.

To run this' property as we feel it should be run requires a. full, range of implements and- to some it may appear to be rather a formidable amount of machinery. For our cultivation work we have a T.D.9 crawler tractor and a Farmall M as well as a Ferguson for some of the lighter jobs. The main plough is a 4-furrow Ransome and we have a swamp plough for breaking in some of the more difficult country. With these go grubbers, grub harrows, tandem discs, tine harrows, roller, drill, and light grass seed harrows. We also use two sets of grass harrows to follow up after cattle grazing. For our swede growing we have a 4-row ridger and 4-row scuffler. For our small seed growing there is a header, an aerater, and a' binder which is retained for the cocksfoot area. We also have a full range of hay machinery, including a baler, as some 8000 bales of meadow hay are required annually, particularly with large cattle numbers.

So far we have not done much mole draining, but we are ready to start on the project with two mole drain ploughs set at 6ft. centres and drawn on one hitch.

The last one of the implements is a gorse cutter, mounted on the Farmall M, which enables us to maintain some 10 miles of gorse fences in good condition with a minimum of labour.

lands. In the field detailed microclimate studies to tie in the other work are just being started.

-Changes in light and temperature conditions can change the whole habit of growth of ryegrass plants. With good light and cool temperatures a sturdy, rapidly tillering plant developed. Where the plants were both shaded and put at higher temperatures there was just spindly growth from the one stem. Tillering. was stopped almost completely. The plants in cool conditions with good light produced 366 mgms of dry matter in 43 days from emergence. Though higher temperature conditions normally speed growth, those at a higher temperature but also shaded took 74 days to produce only 36 mgms of shoot tissue. ,

**Table 1.**

| | Weight of Leaves and "Stems" | Number of Tillers | Days from Emergence |
|---|---|---|---|
| Daylight Low Temperature 57" F. | 366. | 22.1 | 42 |
| Shaded Daylight High Temperature 72" F. | 3 6 | 1.4 | 73 |

Where plants. are changed from one set of conditions to the other they readjust themselves very rapidly. The whole form of growth changes and those changes will often be complete within' a week. Plants transferred from the full light to the shade look almost the same as the ones continually shaded; that is, apart, from their having more tillers. Almost all those extra tillers were present before the plants. were transferred to the unfavourable conditions. Similarly, the plants transferred from unfavourable to favourable conditions appear just a miniature edition of the plants there continuously. The shape and size of their leaves and their whole pattern of growth have changed completely. Equally,. the weight of the plants transferred from shade to full light is considerably greater than where the plants were left under the shade, but much less than where plants were always in full light..

Table 2.

| | | Weight of Leaves and "Stems" | Number of Tillers | Days from Emergence |
|---|---|---|---|---|
| **Transferred from Full** Light-Low Temperature to Shade-High Temperature | O-S | 106 | 4.6 | 4 9 |
| Transferred from 'shade-High **Temperature to Full** Light-Low Temperature | S-O | 108 | 10.4 | 51 |

One of the most important aspects of a plant's growth is the rate at which it forms new tillers. The mean number of tillers present on successive days was recorded. Under cool temperature and full light this increases rapidly, but under' 'shade and high temperature only the occasional plant develops any tillers at all. Where a plant is transferred to favourable conditions it immediately starts tillering vigorously ; actually at the same rate as the plants continually in full light. However, as it got a late start, it does not catch up. On the other hand where plants are transferred to unfavourable conditions very few fresh tillers are formed. Very soon tillering is brought to .a halt and those tillers present change from their previous sturdy, compact form to the spindly, lax form characteristic of, plants under hot, shaded conditions..

The next step is to analyse the various features of a plant's growth to find how these large differences in weight arise. To do that it is first necessary to work out the pattern of growth of the plant.. This 'can best be illustrated by comparing a small, stemmy garden plant with a ryegrass plant. Leaves arise at intervals along the main stem of the garden plant and from the axils of these leaves branches arise. These branches have their own leaves and branches may, arise from their axils. Though it has a tufted appearance, a grass plant is actually following the same pattern of growth. It has a main stem and branches from it, which in their turn produce more branches. The difference in appearance of the two plants arises from the fact that except at flowering time the stem of ryegrass does not elongate. Consequently the leaves are crowded down on to each other, forming the characteristic tuft. The very much shortened branches are now called tillers. The plant is producing almost entirely leaf and no true stem. However, if the plants are drawn as though the stem had elongated, the differences in pattern of growth which lie behind the considerable differences in weight and tillering which were shown in the previous figures can be clearly seen. Plants continually under favourable conditions have their full complement of tillers on the main stem and similar full development of subsidiary tillers on them. Where plants, originally in favourable conditions are transferred to unfavourable conditions, tillers which were already present or appeared very shortly after transfer showed little reduction in their relative development compared with the main stem, but they developed no subsidiary tillers of their own.

On the other hand, where plants originally in the shade were taken to full light, the upper tillers showed about the same amount of development as on the plants continually in full light. Further down the stem the tillers are relatively smaller, due to their late start. However, they are developing their full complement of subsidiary tillers. Right at the base of the stem, however, the tiller buds have been so checked by their long period under unfavourable conditions that they could not be stimulated to grow out by the change to better conditions. Thus a large potential complement of tillers has been permanently lost.

Where the plants are continually under favourable conditions there is a regular progression in the relative weight of successive tillers, each becoming progressively smaller due to its naturally later appearance. A considerable weight of tissue is also contributed by the subsidiary tillers. The earlier and hence the older the tiller the greater the weight of the subsidiary tillers.

Where plants originally in favourable conditions are transferred to unfavourable conditions the relative amount of weight contributed by the lower. tillers on the main stein is little affected. However, there are two marked differences in the pattern of weight distribution. The later tillers on the main stem, being inhibited, made no contribution to the plant's weight.

Secondly, the absence of subsidiary tillers 'causes 'a further very large reduction in weight of tissues present.

Where plants did not come into favourable conditions until half way through development, their late start causes a severe reduction in the weight of the lower tillers and of their subsidiaries.. The latter tillers, however,, show about the same relative weight as on plants continually under favourable conditions.

In plants continually under poor conditions there 'was just a little tissue formed by tiller 4 and none anywhere else. Hence the enormous drop in the weight of those plants.

The results shown above are all taken from a trial with one English strain of perennial ryegrass, S23. Equivalent trials and comparisons of performance have been carried out for New Zealand perennial and for short-rotation ryegrass. All strains show the same general story. S23 has been used to illustrate the position' because its responses are more clear-cut. The main difference has been that in the early stages of development New Zealand perennial ryegrass tillers faster than S23 and short-rotation ryegrass even faster than New Zealand perennial. Equally, the more freely a plant tends to tiller the more difficult it is to prevent tiller development by putting it under poor conditions.

It is emphasised that this appliesto young establishing 'plants. For established plants in a grazed sward the position may be very different. Field observation suggests the tillering differences between the strains are about reversed. An immediate development of this work will be the extension- of our observations to such field conditions.

In another trial the effect of defoliation on the tillering of plants grown at different temperatures was examined. Under the cool conditions of autumn in Palmerston North defoliation slowed up general development slightly, but tillering was just as vigorous irrespective of whether plants were defoliated or not. In contrast, under higher temperatures, say equivalent to fairly dry summer conditions where the air temperature and more important the surface soil temperatures are higher, equivalent intensity of defoliation had considerable effect on the tillering. Further, two defoliations in quick succession are worse -than one. That these differences in tillering are accompanied by large, differences in general habit of growth can be seen from typical plants at equal stages of development. At low temperatures defoliation has reduced their size considerably, but the plants are still sitting tight on the ground and giving every appearance of growing vigorously. This is not so at high temperatures. Here the defoliated plants. show a much greater relative loss of vigour, a considerable change in appearance, and, quite noticeably, tillers standing upright ready to be severely chewed back by the sheep that come-along. It follows that hard grazing under warm summer conditions can be expected to give the plant a much greater relative check than equivalent grazing under cooler autumn conditions.

In these comments major emphasis has been placed on tillering. This is because it is a feature of major importance for the plant's general vigour of growth and rate of production of dry matter. However, it is not the only feature of importance for the production of dry matter nor the only feature which is greatly changed by differences in light and temperature conditions.

Of equal importance is the rate of growth of each tiller. This can be judged by the time taken to produce 8 leaves on the main stem and the total weight of those 8 leaves. With the S23 plants under low temperature and full light 42 days were required for the production of the 8 leaves which weigh 39 mgms. Under high temperature and low light it took '73 days and even then leaves weighed 38 per cent. less.

**Table 3.**

| | Weight of 8 Leaves on Main Stem | Days from Emergence |
|---|---|---|
| Daylight- Low Temperature 57° F. | 39 | 42 |
| Shaded 9% Daylight and High Temperature 72 F. | 26 | 73 |

The relative effects of light and temperature can best be shown by results from work done in a constant environment growth cabinet. It records the time between successive leaves, which is a fair measure of rate of 'tissue formation. The interval is greatest at low light and low temperature, is decreased by raising either temperature or light intensity, and is least where both are high.

So far the roots have been left out of the discussion. Light and temperature conditions affect the root system just as much as the tops. The short-rotation plants grown under low temperature and full light have a large complement of vigorous, thick white roots firmly anchoring them to the ground. With poor light and high temperature the few roots which do develop are thin, brown, and extremely weak. The slightest tug, say when an animal attempts to nip off the top, is often sufficient to pull the plant right, out of the ground. With a change to good light, etc.,' the root system improves almost as quickly as the tillers above ground.

In conclusion it is re-emphasised that this work is in its initial stages. Here there has been solely an attempt to show you the considerable differences in rate and form of growth of one and the same plant type when put under different light and temperature conditions. At further conferences it is hoped to describe the differences between various species and strains in their efficiencies under various conditions, and along with it the integration of this information to. throw light on a range 'of establishment and management problems.

Mr Brougham's paper on the sowing down and establishment of short-rotation pastures gives one instance of how the information can be used.

DISCUSSION

Q. (C. Marshall): 1. Has any work on these factors been done in grazed plots in the field?
2. Has work been done on the influence of these factors on feeding value?

A. 1. The stage has not been reached where the work could be done on grazed plots. The influence of at least 6 factors on the growth of pastures has to be sorted out; the problem is too complex to be studied initially in the field.
2. A beginning has been made on work to assess the effect of light and temperature on chemical composition and from this it should be possible to obtain information on variations in feeding value.

Q. (Hurst): Have long hours of daylight anything to do with the high tillering of pastures in Southland during the summer compared with that in Canterbury?

A. The relative importance of light and temperature cannot yet be definitely stated. It is doubtful 'if the difference in the period of light between Canterbury and Southland is of great Importance; Higher soil temperatures and lower soil moisture of Canterbury are probably more important.

Q. (Lynch): 1. In trials at Ruakura pasture production was positively correlated with soil temperature. This seems to be opposed to Dr. Mitchell's results.

2. Has any work been done to separate the effects of light and temperature?

A. 1. Within a reasonable range growth is, of, course, greater at warm rather than cool temperatures, other factors being equal. However high temperatures can be deleterious,. particularly in the rate of formation of tillers, This effect is greatly increased by shading. In this paper I have attempted! to show extreme examples of the differences which can occur.

2. Most of the work done in the controlled environment cabinet had been designed to separate the effect of temperature and light on growth of short-rotation and perennial ryegrass. If both temperature and light are adequate, both, species grow with equal efficiency. This also applies if temperature and light are both low. But with adequate light and low temperatures the efficiency of growth of short-rotation is better than that of perennial, hence the better winter growth of short-rotation ryegrass.

Q. (Dr. Hamilton): What is the optimum temperature for the growth of ryegrass if all other factors are adequate ?

.A. The optimum temperature conditions are not known at present. We are trying to work out rates of growth at various temperature levels from which to present curves' showing the relationship between temperature and growth. The temperature at which best growth occurs wiill vary according to conditions such as light, soil moisture, and the general state of the pasture. Accordingly it is not possible to. state the actual optimum temperature, but merely the performance of plants under various sets of specified conditions.